1: Bowen-Jones et al. K-5 (1955-1958) 1961
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C. HYDROLOGY AND WATER SUPPLY

An adequate water supply being essential to all forms of economic activity, industrial as well as agricultural, it is not surprising that a great deal of attention has been paid to this topic in Malta where, as in so many regions of Mediterranean climate, a limited and erratic rainfall makes water supply a perennial problem. This has become increasingly serious and difficult of solution during the period of British rule. Rapid growth of population and a rising standard of living have been accompanied by increasing water consumption per head as well as overall. A long series of reports of varying worth and conflicting conclusions has appeared during the last 50 years of which the Morris Report (1) published in 1952, is the most recent and most authoritative. This work is of interest not only for its thorough treatment of modern conditions but also for its critical appraisal of earlier published work. It forms the basis of current policy in the field of water supply development. [114]

Climate in general and precipitation in particular are more fully dealt with elsewhere (Chapter II, p.48). Suffice it to say at this point that the heavy, often very localised downpours accompanied by rapid run-off, in which the bulk of the rainfall occurs, together with summer drought and intensive evaporation, are factors which greatly reduce the value of a by no means abundant precipitation.

Malta is fortunate in its stratigraphy (see Chapter IA, p.25) which provides particularly favourable conditions for the percolation and undergrqund storage of rainwater. The most valuable aquifers are the Upper and Lower Coralline Limestones where, however, the presence of bedding planes, joints and fissures is of far more importance in controlling the underground movement of water than are the porosity and permeability of the rocks themselves. The Globigerina, though it contains important limestones, is composed largely of thick and relatively impervious marly beds, through which percolation is slow and from which run-off is correspondingly rapid.

Two distinct water tables (2) exist, one in the Upper Coralline and the other in the Lower Coralline and Globigerina formations. There is a further subdivision into water tables based on sea level and those developed above impermeable strata. Physical conditions and the history of development of the two sources are so distinct as to warrant their separate treatment at this stage. The Main Sea Level Water Table (or the Lower Water Table) so named to distinguish it from smaller sea level tables occurring in the Upper Coralline, has for the past hundred years been the main source of the public supply in Malta and now accounts for some 90 per cent, or more the water extracted by the Water Department. This water table 'is in bodily continuity with water of Mediterranean salinity marginally and at depth... It is not retained within the island by any impermeable base, but owes its existence to the simple fact that every winter the local rainfall adds more fresh water to the underground store than can be dissipated by (i) the direct discharge of its superficial portion around the coast in response to the head of water inland and (ii) the deterioration of its composition ... as the result of diffusion from the highly saline Mediterranean water around it and beneath it' (3).

The area occupied by this water table is bounded by (a) the coast where the Lower Coralline outcrops and (b) the line along which the junction of the Lower Coralline with the Globigerina lies at sea level (Fig. 6). The area thus defined occupies 37.5 square miles south of the Victoria Lines and 4.3 to the north, the most valuable parts being those where the salinity of the top water does not exceed 15 parts per 100,000. Such conditions are limited to an area of 22.8 square miles. The water body is replenished for the most part through the extremely limited outcrops of Lower Coralline since the Globigerina, especially where it is soil covered, forms a region of very slow percolation. Thus it is of particular importance that the Lower Coralline catchments should be preserved and protected from pollution. Such areas are rarely cultivated but it is unfortunate, though not unnatural, that they are often used for other purposes, in many

312 cases being built over (e.g. the Incita Asylum, the Government Poultry Farm, St. Andrew's Barracks, etc.) and in others being used as refuse dumps (e.g. parts of the Wieds Qirda and Has-Saptan). The small section of the Lower Water Table which lies to the north of the Victoria Lines in the Wied il-Ghasel district is very limited in value. Deep fissures result in the mixing of salt water with fresh and development beyond that already undertaken privately is most unlikely to occur.

The Upper Water Table has been broken into a series of blocks by faulting and the Upper Coralline Limestone aquifers, in which water movement is controlled mainly by fissures, are often thin, so that storage possibilities are limited. However, there is considerable scope for further development. Upper Coralline sea-level water tables occur in Marfa, the Mellieha Isthmus and Wied tal-Pwales, but these are already used to such an extent for agricultural purposes that salinity has become a serious problem (see Chapter VIII, pp. 240 and 243). It is the high-standing water tables, sealed off by the Blue Clay beneath, which are the most important though hitherto largely neglected sources, particularly in the Mizieb and Bingemma Basins, where perched synclines collect water from the neighbouring uplands.

Replenishment of the Upper Water Table, like that of the lower, depends largely on the character of the surface and it is here that a conflict of needs becomes apparent. Expansion of the rural population over the past hundred years has been accompanied in many districts by expansion of both soil cover and building on the Upper Coralline. The former reduces percolation and creates a bigger demand for irrigation water. Several areas in which over-pumping for agricultural purposes occurs have been noted during the present survey, e.g. the Rabat-Dingli Plateau. The growth of settlement inevitably increases both water consumption and pollution. As Morris points out, there is 'a clash of interests between the local agricultural communities and the much more numerous... urban section of the population' (4). To suggest, however, that 'any further expansion (of soil cover) over the upland catchment areas should be prohibited' (5) appears unrealistic and favours the urban element at the expense of the cultivator. The towns must first make their contribution by restricting consumption which has recently increased at an unnecessarily rapid rate. Prohibition of building on Upper Coralline areas might, with more justice, be enforced.

PRESENT UTILISATION OF WATER SUPPLIES: That urgent action is required, not only to increase production from the Upper Water Table but also to regulate consumption is readily apparent, for extraction has now risen above the rate of replenishment in the Main Sea Level Table. Morris, writing in 1952, suggested that a total extraction rate per annum of 2,500 million gallons with an average salinity not exceeding 28 parts per 100,000 could be achieved. Of this, however, 1,500 million gallons with a salinity of 12 or less should come from the Upper Coralline, while 1,000 million gallons *only* would come from the Lower Water Table, even if the acceptable limit of salinity was to be set at 50 parts per 100,000. In fact, rapidly increasing consumption has already brought the total of extraction by the Water Department to a level very little below the suggested maximum and over 90 per cent. comes from the Main Sea Level Table. The amount of water drawn from this source has increased from 1,460 million gallons in the year 1945-46 to 2,106 million gallons in 1955-56, that is by over 40 per cent. in ten years. During the same period, the total consumption of piped water has risen by a similar proportion although the population has increased by only 4 per cent. Average salinity of water drawn from the Lower Table has fluctuated considerably during this period with an overall tendency to rise. The maximum recorded was 93.7/100,000 in 1947-48. The scale of longer term change is illustrated by a salinity figure in the region of 20 for the year 1900. Average salinity is in any case a somewhat artificial concept since the chloride content of the water varies both regionally and from one season to another. Regional variations in the average salinity are illustrated in Fig. 6 and are extremely important in their effects on agriculture. Seasonal variations are equally great

1: Bowen-Jones et al. K-5 (1955-1958) 1961
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and indicate the deterioration of the piped water supply. In order to keep up with the demand it has been necessary on occasions to pump water with a salinity as high as 245/100,000 (6). 312

Attention has been drawn on many occasions to the dangerous combination of increasing consumption and the associated rise in salinity. The point is most strongly made by Morris: 'The Main Sea Level Water Table is being grossly over-pumped. In a few years' time no water fit for human consumption will remain unless the present rate of extraction is reduced drastically' (7). This warning has been reiterated in the annual reports of the Water Department. A good deal is being done to implement suggestions for the development of the Upper Table, particularly at Mizieb, but also in the Bingemma Basin. As yet, however, there has been no reduction whatsoever in the rate of extraction from the Lower and, since Malta will necessarily depend primarily on the latter source for many years to come, rigid control of all uses, domestic, industrial and agricultural, must be maintained. Restrictions on consumption must be applied as a matter of principle and not confined to years of below-average rainfall when the problem is more readily apparent. An unsatisfactory attitude is, for example, illustrated in the Water Board Report for 1953-54 when a winter of plentiful precipitation was followed by a summer which 'went by without the usual economy campaign for saving water and without subjecting the consumer to drastic restrictions'. In fairness to the Board it should be pointed out that the Report made it clear that 'this might be construed to mean that the water situation... is no longer critical. Nothing could be further from the truth. The higher consumption... has had to be painfully met at the cost of higher salinity ... the present rate of over-pumping is suicidal' (8). However, sustained action rather than exhortation is required.

IRRIGATION: The foregoing paragraphs have been confined almost entirely to a consideration of the piped water supplies to towns and villages, a subject on which much information is readily available. Of greater relevance to the present study, however, are the demands of irrigation which, in one form or another, is carried on wherever conditions permit. Though sample studies have been made from time to time, there is as yet no really complete information on the amount of water used in this way but the quantity applied to the land is believed to be little less than that passing into the piped supply.

A few general remarks are appropriate at this stage. In the first place, though published agricultural data give figures for the areas of 'irrigated' and 'dry' land, it is by no means easy to draw a clear dividing line between the two, nor is it certain that the farmers' returns are exact on this point. Water is applied to the land in many ways. At the 'drier end of the scale' are the many areas in which crops are hand watered from cisterns cut into the rock. At least 10,000 of these are erroneously marked as 'wells' on the larger-scale maps and many more have no doubt been omitted. They are largely confined to the Globigerina lands. Secondly, innumerable pumps of various kinds; wind-, motor- and donkey-powered, tap all water tables. In some cases they are used to fill rock-cut or concrete tanks from which water is carried to the fields; in others, the tanks feed into stone channels or temporary earthen ditches. Wind-pumps are particularly important on the Upper Coralline plateaus, in many parts of which they have been sunk in excessive numbers thus lowering the level of water table. They are less numerous, though by no means unimportant in the Sea Level Water Tables whether these be developed in downfaulted Upper Coralline or in Lower Coralline and Globigerina. Here, pumping has often led to rapid increases in salinity and some such cases are commented upon in Chapter 8. Finally, the areas in which water is most plentiful are those fed from spring lines occurring where the Blue Clay outcrops from beneath the Upper Coralline Limestone.

It is believed that at least 2,000 million gallons a year are used for irrigation purposes. Various sample data are available to illustrate the scale of agricultural water consumption. An official survey of private wells in Malta is now under way and by March 1956, 2,912 of these had been recorded (9). 2,200 tapped the Upper Water Table and drew 260,582 gallons in the year 1955-56.

[Text continues on page 47]

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A further 295 in the Main Sea Level Water Table produced 606,329 gallons, while 312
407 in the depressed parts of the Upper Coralline yielded 409,881 gallons, a total of 1,376,762 gallons from less than 3,000 pumped wells. The problem of salinity in sea-level water tables is illustrated by the Wied tal-Pwales where in 1945 private wells yielded water with a salinity ranging from 22 to 142/100,000 while in 1953 the corresponding figures were 25 and 200/100,000 (10).

Finally, an accurate check has been kept on water obtained from those springs on the Rabat-Dingli Plateau which feed aqueducts for town supply. Over a period of years these have yielded an average of 251 million gallons annually, equivalent to 26.7 per cent. of the supply provided by an average yearly rainfall of 20.51 inches on a catchment area of 3.16 square miles (11).

A survey carried out by J. Baldacchino in 1942-45 provides some data on the amount of water used to irrigate various crops (12). There can be little doubt that much water is wastefully applied. The highest rate of application was that to summer marrows which received 30 waterings, 210,000 gallons per tomna, the equivalent of 33 inches of rain. The most striking fact, however, concerned the spring potato crop which took 15 waterings, 90,000 gallons per tomna, equivalent to 15 inches of rain. This was water applied from January to April, some of the wettest months of the year, and is perhaps an adequate comment on the suitability or otherwise of this crop to Maltese conditions - a question raised elsewhere in the present volume. Careless storage and prodigal application of water under conditions of intense isolation and evaporation indicate an uneconomic use of a limited resource.

Irrigation and the piped supply thus appear to make approximately equal demands on water resources - now, a probable 2,000 million gallons in the case of the former and a more certain 2,415 million gallons in the latter. This total of over 4,400 million gallons consumed annually may be compared with an annual supply from rainfall of 27,550 million gallons (assuming an average precipitation of 20 inches over an area of 95 square miles). What is not known is how much of this latter total percolates to the water tables and how much is lost at various stages of the water cycle by direct run-off, evaporation, transpiration and seepage into the Mediterranean. Some of the answers will be provided by the evapotranspirometer stations recently established in Malta.

Gozo has not thus far been mentioned and relatively little hydrological 184
investigation has been carried out there. The general arrangement of water 312
tables irrigation practice, etc., are little different in principle from those described for Malta. The lower population density, the absence of a large urban element and the generally lower standard of living in the material sense make the problem a good deal less acute. Consumption per head from the public supply is approximately half that of Malta.

There is in the Maltese Islands, and particularly in Malta itself, conflict 312
between urban and rural uses of water just as there is in the use of labour, land 369
and capital. When the resource is already limited as it is in the case of water, the conflict becomes more apparent and its resolution depends on economic as much as on purely physical factors. Water shortage is a background against which all plans for future development, including the industrial, must be viewed.

REFERENCES

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(1) MORRIS, T. O.: The Water Supply Resources of Malta. Govt. Printing Office, Valletta, 1952.
(2) By common usage in Malta, the term 'water table' is applied to the whole body of water contained within the aquifer and not, as elsewhere, to its upper surface alone.
(3) MORRIS, op cit., para. 153, p. 62.
(4) ibid., para. 225, p. 109.
(5) ibid.
(6) Report on the Working of the Water and Electricity Department for the Year 1953-53; Govt. Printing Office, Valletta, 1954. Para. 11.
(7) MORRIS, op cit., footnote to table 15.
(8) Report on the Working of the Water and Electricity Department for the Year 1953-54; Govt. Printing Office, Valletta, 1955. Para. 3.
(9) Report... etc., for the Year 1955-56. Appendix IV.
(10) Report... etc., for the Year 1952-53. Appendix IV.
(11) MORRIS, op cit. Table 8.
(12) ibid. Table 14.

1: Bowen-Jones et al. K-5 (1955-1958) 1961
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EVAPORATION AND EVAPO-TRANSPIRATION

In the foregoing pages, attention has been drawn to the great variety of rainfall conditions in the Maltese Islands and an attempt has been made to assess the character of 'wet' and 'dry' years and seasons. Such terms, however, can never be absolute in terms of rainfall amount, since 'wetness' and 'dryness' are the product of a variety of factors including run-off, percolation, sub-surface drainage and soil-moisture conditions which, together with evaporation, all play their part in determining the effectiveness of a given amount of rainfall.

Little attention has been paid to the measurement of evaporation in Malta though some early work was done by Zammit (28) during 1845 and 1855 and at the University Observatory in 1878 (29). However, the results, as tabulated in Table 15, are far from satisfactory. No other records of evaporation in the Maltese Islands are available and Mitchell's field experiments in 1957-58 break practically untrodden ground.

Table 16. Open Water Evaporation in Inches.
Zammit's and University Measurements.

	A	S	O	N	D	J	F	M	A	M	J	J	Yr.
Zammit 1854/55	8.0	7.7	4.4	2.3	1.7	1.7	2.3	2.1	5.0	6.0	9.6	10.6	61.5
University 1878	10.4	7.8	6.0	5.3	4.6	3.6	3.8	6.5	6.8	10.0	11.6	12.8	89.2

The early experiments referred to above were concerned with evaporation from an open water surface. From the agricultural point of view, evapo-transpiration from soil with a vegetation cover is of much greater significance. If a plant cover is provided with an adequate moisture supply, it will transpire at the greatest possible rate and the water given off in this way will be taken into the surrounding air at the potential rate of evapo-transpiration for the particular plant under the weather conditions prevailing at the time. Thorne-thwaite (30) and Penman (31) have indicated that the study of potential evapo-transpiration through a grass-covered surface yields results which may be applied under a wide range of conditions and which provide basic data for controlled irrigation development.

As a first stage in the study of the water balance in the Maltese Islands, two potential evapo-transpirometers were installed during the early summer of 1957, the design and operation of the instruments being based on the practice of the U.K. Nature Conservancy (32) and on techniques developed and tested at Seabrook, NewJersey (33) and Ibadan, Nigeria (34). The sites chosen were at ta'Qali Pumping Station and at the Royal Naval Air Station, Hal Far (respectively the sites marked H, in the centre of the Island, and S in the south-west in Fig. 9). The local environments of these sites are sufficiently dissimilar to give a fair indication of the possible range of conditions in Malta. It is hoped that this pilot scheme will be developed by the installation of other instruments in various parts of the Islands.

It was found necessary to make adjustments to the crude data obtained from the ta'Qali and Hal Far. The methods used, together with the installations themselves and their sites, are fully described elsewhere (35). The adjusted monthly data are given at Table 17 and Fig. 20.

Table 17. Values of monthly potential evapo-transpiration from field-tank observations 1957-58. (Adjusted.)
Expressed in rainfall equivalent (inches).

		A	S	O	N	D	J	F	M	A	M	J	J	Yr.
ta'Qali	1956-57									4.1	5.0	4.9	6.5	
	1957-58	8.0	4.1	3.3	2.0	2.2	1.6	1.3	2.7	2.4	3.8	4.9	5.0	41.3
	1958-59	5.8												
Hal Far	1956-57									4.6	6.0	5.4	6.5	
	1957-58	8.3	6.8	4.8	3.4	3.1	2.5	3.0	3.3	3.9	6.3	6.5	7.0	60.9

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Fig. 10

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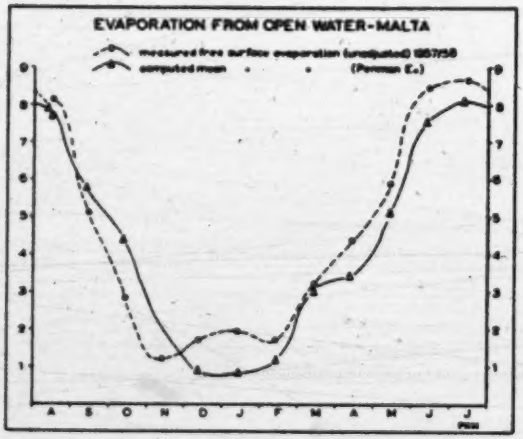

Fig. 22 Evaporation from open water, Malta.

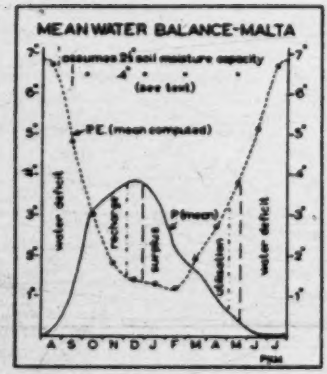

Fig. 23 Mean Water Balance, Malta.

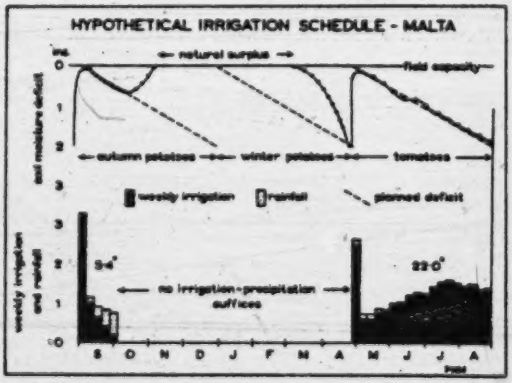

Fig. 24 Hypothetical Irrigation Schedule, Malta.

1: Bowen-Jones et al. K-5 (1955-1958) 1961
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Despite the considerable differences in the two totals for the full year 1957-58 which may largely be explained by differences in the exposure of the two instruments, the broad trend of potential evapo-transpiration is clearly evident (Fig. 20). The maximum occurs in August when the rate approaches a quarter-inch per day and falls off rapidly to a minimum of about 0.05 inch in December, thence rising slowly, and somewhat irregularly, to the August peak. Certain of the monthly figures appear inaccurate. May and June 1957 would seem to be too high and too low respectively. Settling of the soil may be responsible for the irregularity of these early values but can hardly explain a similar pattern in 1956. Difficulties experienced in maintaining a vegetation cover may be a further factor in distorting the values for these months. The high November reading at Hal Far is almost certainly due to the 'bushy' vegetation at the time.

Thornethwaite (36), Penman (37) and Crowe (38) have produced formulae for the calculation of P.E. from standard meteorological data. The application of these formulae to mean monthly data for Malta is shown in Table 18. Comparison with the ta'Qali and Hal Far figures is encouraging (Fig. 21). A further comparison is made in Fig. 22 between mean values computed according to Penman's formula for evaporation from an open water surface and the results of observations at the ta'Qali free surface evaporation tank, kindly made available by the Senior Water Engineer. Again, the two curves are tolerably close.

Table 18. Computed mean monthly evapo-transpiration. Inches.

	A	S	O	N	D	J	F	M	A	M	J	J	Yr.
Thornethwaite, P. F.	6.2	4.7	3.4	1.9	1.3	1.0	1.0	1.4	2.1	3.2	4.7	6.4	37.3
Crowe, P. E.	7.1	4.8	2.6	1.7	1.4	1.5	1.4	2.4	3.3	4.4	5.4	7.0	43.0
Penman, Fo.*	8.0	5.9	4.5	2.3	1.0	1.0	1.3	3.1	3.5	5.2	7.6	8.1	51.5

*Evaporation from open water.

It seems probable that Zammit's figures, appropriately adjusted, would provide reasonably correct results. The University data, however, are excessive owing to deficiencies in the apparatus (the pan was only 2 inches deep and back radiation from its base would have heated the water and speeded up its evaporation). The low August values of these early readings may well be related to this insolation effec., since their rhythm is more closely linked with insolation than with air temperature. It is the latter which normally controls deep water evaporation and potential evaporation, though, as Penman points out (39), atmospheric humidity, wind and insolation are also significant.

Clearly, further work is necessary before any final conclusions can be drawn. Observations made so far must be regarded as preliminary, though the results are sufficiently consistent to justify the following statements on the 'water balance' of the Maltese Islands.

THE WATER BALANCE OF THE MALTESE CLIMATE

The water balance is essentially the relationship between water requirements as expressed by potential evapo-transpiration (P.E.) rates and the availability of water from precipitation. Table 19 gives mean monthly values of P.E., computed according to the methods suggested by Thornethwaite and Crowe (40).

Table 19. Crude water balance - Malta. Inches.

	A	S	O	N	D	J	F	M	A	M	J	J	Yr.
Precipitation	0.2	1.1	3.1	3.6	3.8	3.5	2.2	1.6	0.9	0.4	0.1	0	20.5
Potential evapo-transpiration	6.7	4.8	3.0	1.8	1.4	1.3	1.3	1.9	2.7	3.8	5.1	6.7	40.1
Moisture surplus			0.1	1.8	2.4	2.2	1.0						7.5
Moisture deficiency	6.5	3.7						0.3	1.8	3.4	5.0	6.7	19.6

1: Bowen-Jones et al. K-5 (1955-1958) 1961
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#137 134 312 The figures show that annual P.E. exceeds annual precipitation by nearly 100 per cent., a moisture surplus of 7.5 inches for the months of October to February inclusive being more than offset by a moisture deficiency of 19.6 inches, almost as great as the average rainfall, in the remaining seven months of the year. In practical terms this means that the maintenance of a herbaceous vegetation cover throughout the year would require a water supply equivalent to 40.1 inches of rainfall distributed according to the monthly P.E. values. Rainfall itself supplies only half this amount and the remainder must come from other sources as, for example, when irrigation is applied. In the latter case, water is brought in from elsewhere, during the limited growing season of cultivated plants, to supplement the supply from precipitation. However, the position is less simple than suggested by the foregoing statement. Application of water at the required rate can damage the soil by preventing proper aeration and may also cause disease in the growing crop. On the other hand, if the total amount of water supplied to a crop falls below the cumulative P.E. rate of the growing season by more than an inch or two, then full growth of the plant is prevented. Furthermore, surplus moisture will be stored in the soil from the wetter months to augment the supply in months of rainfall deficiency, the extent to which this takes place being dependent on such factors as type and depth of soil and the nature of the crop itself. Thornethwaite (41) has shown that, in humid areas, the majority of crops can only abstract 4 inches of water from the soil in this way but such a generalisation cannot apply to many of Malta's extremely thin soils, which are physically incapable of retaining so much water. The moisture-holding capacity of the soil is also significant in relation to run-off which will only occur once that capacity has been exceeded.

134 312 There are as yet, no data on the moisture-holding capacity of Maltese soils. In the computations which follow (Table 20), three values have been assumed - 2½ inches, 4 inches and 6 inches - of which the intermediate is the most likely average. These fuller figures give a truer picture of the water balance than that available from the moisture surplus and deficiency data of Table 19.

It will be observed that the whole moisture surplus of October and November is absorbed in soil moisture recharge, that is in the replacement of moisture removed from the soil during the dry summer months and that it is not until December that an actual water surplus occurs and that there are, in fact, only three months with such a surplus (two in soils with 6 inches storage capacity), which will be expressed in direct run-off and in percolation into the water table.

On the assumption made in the computation of Table 20 that evapo-transpiration will take place at the full potential rate so long as there is any moisture stored in the soil it will be seen that the length of the growing season depends on soil moisture storage capacity. Thus, at the 2½ inches level, full plant growth is possible from October to early May (Fig. 23), at the 4 inches level, the season is extended by some two weeks and, at the 6 inches level, it would continue into early June. Water surplus also varies with soil character; so does the date at which significant run-off begins.

If the average soil moisture storage capacity is assumed to be 4 inches, December-February water surplus is seen to be 3.5 inches. Since this is based on the Valletta rainfall data it would be wise to raise this figure to 4.2 inches for the Islands as a whole (see p 75). Making the further (erroneous) assumption that the land surface is completely covered with soil, the total available water, including both percolation and run-off, would be some 7,000 million gallons. We have already seen (p. 45) that some 2,000 million gallons are used for irrigation and a further 2,400 million in the public water supply. If it is further recalled that a good deal of the precipitation is lost by direct run-off or by sub-surface percolation into the sea (p. 43) it will be realised that the 'water balance' is in fact in a precarious state of unbalance.

There are several implications here for the agriculturalist. In the first place, there is little prospect of obtaining additional water for irrigation purposes in years of average rainfall. Secondly, it is essential that excessive amounts of irrigation water should never be applied. Some indication of irrigation requirements may be obtained from P.E. data and an attempt has been made (Fig. 24)

Table 20. Water balance - Malta. Inches.
Assuming soil storage capacities of 2½ inches, 4 inches and 6 inches.

	A	S	O	N	D	J	F	M	A	M	J	J	Yr.
Moisture surplus			0.1	1.8	2.4	2.2	1.0						
Moisture deficiency	6.5	3.7						0.3	1.8	3.4	5.0	6.7	19.8
Soil storage capacity 2½ inches													
Soil m. recharge			0.1	1.8	0.6								2.5
Water surplus					1.8	2.2	1.0						5.0
Soil m. utilisation								0.3	1.6	0.6			2.5
Deficiency	6.5	3.7								2.8	5.0	6.7	
Soil moisture deficit	2.5	2.5	2.4	0.6	0	0	0	0.3	1.6	2.5	2.5	2.5	
Soil storage capacity 4 inches													
S.M.R.			0.1	1.8	2.1								4.0
W.S.					0.3	2.2	1.0						3.5
S.M.U.								0.3	1.6	2.1			4.0
D	6.5	3.7								1.3	5.0	6.7	
S.M.D.	4.0	4.0	3.9	2.1	0	0	0	0.3	1.9	4.0	4.0	4.0	
Soil storage capacity 6 inches													
S.M.R.			0.1	1.8	2.4	1.7							6.0
W.S.						0.5	1.0						1.5
S.M.U.								0.3	1.6	3.4	0.7		6.0
D	6.5	3.7									4.3	6.7	
S.M.D.	6.0	6.0	5.9	4.1	1.7	0	0	0.3	1.9	3.3	6.0	6.0	

to prepare an irrigation schedule on the basis of the figures discussed in this chapter. The schedule is for a field in which potatoes, sown in September, are followed by further potato plantings in January and by the setting-out of tomatoes in late April. Regular P.E., rainfall and irrigation are assumed and soil moisture deficit of 2 inches at the end of each crop's growth is permitted (a figure allowed for shallow-rooted crops in U.K. Ministry of Agriculture experiments). The schedule indicates a maximum irrigation of 3.2 inches in the week of planting first-crop potatoes (when soil moisture deficit must be restored) and a similar amount is applied to the young tomatoes. The potatoes require less irrigation in subsequent weeks when soil moisture is near capacity and rainfall is increasing while P.E. is falling. A total of 5.4 inches of irrigation is required by this crop. Winter-sown potatoes need no irrigation but they deplete soil moisture reserves which must be restored when tomatoes are planted. During the growing season of the latter crop, soil moisture is allowed to decline but P.E. is increasing and irrigation rates rise from 0.6 inch per week in early May to 1.5 inches in July, the latter being equivalent to 9,450 gallons per tomna. The tomato crop requires a total of 22 inches.

It must be emphasised that this schedule is based on average conditions and on an even distribution of rainfall within each month, conditions which rarely, if ever, occur. The method, however, might be more profitably applied on the basis of P.E. rates, rainfall and precise planting dates in particular seasons. When more information on P.E. rates in Malta becomes available, experiments in the application of the water balance technique to the problem of irrigation might well show a profit in a more efficient use of water supplies.

1: Bowen-Jones et al. K-5 (1955-1958) 1961
EZ6 Malta EZ6

THE MOISTURE REGIME OF THE MALTESE ISLANDS

The Maltese climate provides more moisture at the season when there is least demand for it, that is when the rate of plant growth is at its slowest. Conversely, when the potential for plant growth is highest, natural moisture is almost completely absent. Though winter temperature conditions allow the growth of a wide range of crops, some of the most valuable, e.g. tomatoes, would be unlikely to survive the winter season. Thus there have developed a number of types of crop management.

(1) Rain-fed crops are (a) planted before the onset of the autumn rains and watered artificially until adequate natural moisture is available, or (b) are sown mid-way through the rainy season when soil moisture is at a maximum. In all but the driest years, watering is unnecessary though, if applied, it can lead to higher yields.

(2) Crops dependent on soil moisture are generally planted late in the rainy season, when rainfall alone would be inadequate for their support. Land used in this way has generally been left fallow during the winter and repeatedly ploughed, thus keeping weeds down and reducing water loss from the bare soil. Even in average years, however, soil moisture will only support plant growth for a month or two and summer watering would be valuable but is not always possible.

(3) In irrigated areas, three crops a year are possible all depending to some extent on 'imported' water to supplement rainfall and soil moisture supplies. Areas in which this is possible, however efficient the methods used, are inevitably limited in extent.

Husbandry is largely controlled by considerations of this sort. Shallow ploughing is impossible until the onset of the rains has weakened hard surface crusts but is also difficult if the soil becomes excessively wet. The farmer thus hopes to cultivate and sow during the November dry spell (the Sajf ta'San Martin) which often follows earlier rains. In all but a few years, this traditionally hoped for dry period does in fact occur.

Ploughing is also carried out on a large scale in high summer when deep cultivation, with manuring, is carried out every fourth year. There seems to be no particular reason why this should be done in the summer months except that it is then that a large labour force is available. With mechanisation, labour supply is no longer a controlling factor but the practice persists. Certainly the movement of tractors and heavy ploughs about the countryside is most easy when the bulk of the land is fallow. The danger here is that deep-ploughed land may suffer soil erosion if there is an early onset of really heavy rain.

The timing and violence of the onset of the wet period are very uncertain. Generally the farmer aims at conservation of the early rains and does all he can to reduce run-off and to assist soil moisture recharge. If the autumn is wet, however, as in 1957, saturation of the soil and serious gullying may result from such traditional activities as the diversion of water from roads to fields by the construction of temporary earth dams and channels. A long term forecast of autumn weather would, if feasible, be of great value.

In the summer months, plant growth is often slow as a result of moisture deficiencies but there are obvious compensations. The ripening of vines continues unhindered, though the grapes may be damaged before harvest by early heavy showers. In spring and early summer, grains and legumes ripen and dry with little interruption.

There can be little doubt that current Maltese farming practices are adjusted to average conditions. It is the frequent occurrence of 'non-average' seasons which causes most damage (Figs. 25 and 26). Flexibility to cope with departures from mean conditions must be a major consideration in any plans for agricultural development.

1: Bowen-Jones et al. K-5 (1955-1958) 1961
EZ6 Malta EZ6

They seem to be largely devoted to cereals and potatoes, and in general give relatively poor crops. These soils are in several areas widely abandoned because they are uneconomic to work. 134 311

SOIL NEEDS

The needs of a soil, for the improvement of its fertility, are not simple to assess, and in the Maltese Islands at present they are not known. A fertile soil is considered as one which is in the optimum condition for the growth of crops, and this is dependent on a variety of factors, physical and biological as well as chemical. Air and water must be available, and man by cultivation and irrigation attempts to influence their disposition to favour his crops, just as by using fertilisers and weed or pest killers he attempts to influence the chemistry and biology of the soil.

PHYSICAL NEEDS

A soil which has a poor physical structure may be unable to support good crops, because water cannot be conducted to the plant easily enough, or because the soil aeration is poor. The heavy clay soils of the Fiddien series have poor structure, and it probably is the correlated difficulty of wetting the soil rather than the chemistry of the soil material (which often has a rather high concentration of exchangeable sodium and soluble salts) which causes it to be nearly useless for agriculture.

In the majority of cases the Maltese soils have a reasonably good structure, and the only other soils which appear to be ill-favoured are the heavy-textured soils of the Xaghra series. In this case the subsoil is often very compact indeed, and the separations between structural units are minimal. However, where such soils are well worked, and more particularly where they are irrigated, the structure seems to be much improved, partly no doubt because of the increased and active microfauna. While irrigation is probably difficult to extend, the use of improved cultural practices on these soils would probably produce an increase in the soil organic matter content and improvement of the structure. Among such practices the use of nitrogenous fertilisers, use of improved rotations, encouragement of root growth, avoidance of oxidation of root-derived organic matter through unnecessary turning over of the soil, and the avoidance of pulling cereals as a method of harvesting, might cause considerable improvement. The application of animal manure in irrigation water as already practised locally in Malta also appears to be effective in increasing organic matter content of the soil. 134 242

One of the chief problems of all crops in the Maltese Islands, is water. Certain of the lighter textured soils are extremely dry, and conservation of rainwater rather than extension of irrigation must be the answer because domestic water needs are already difficult to satisfy. Apart from practices designed to diminish evaporation loss, especially early removal of weeds by hoeing, it is probable that increasing the organic matter content would considerably increase the ability of the soil to hold water. But another simple possible method would be to marl some of the lighter soils with the calcareous clay, e.g. Fiddien heavy clay, which is not in agricultural use. (This would in addition possibly make more nutrients available.) 134 [312]

As far as aeration is concerned, it seems unlikely that it is deficient in many soils at present; but use of a rototiller (common in Malta) is believed to decrease aeration, and this could be investigated quite simply. It is possible that an excess of soil CO_2 would be beneficial in calcareous soils, reducing the pH of the soil solution to a level at which there is greater availability of most nutrients; and particularly those, such as phosphorus, which are likely to be deficient.

CHEMICAL NEEDS

Despite some other possible deficiencies it seems likely that nutrient

[TEXT CONTINUES ON P. 97]

1: Bowen-Jones et al. K-5 (1955-1958) 1961
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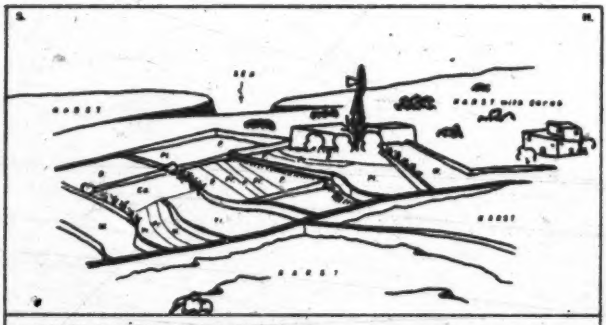
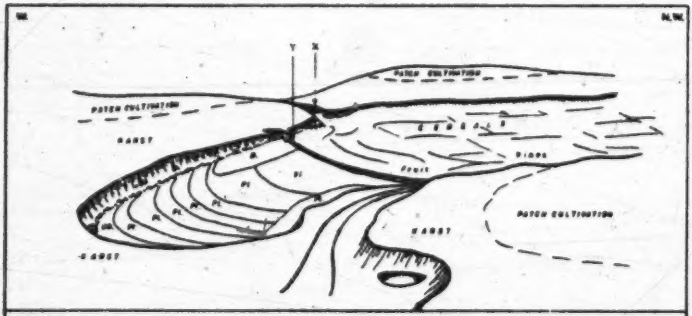


A: SANTI-BINGEMMA UPLANDS (XIII) Cultivated pocket at 650ft, M.R. 412713



B: SANTI-BINGEMMA UPLANDS (XIII) Santi Gap (57) Pt. of OBS. M.R. 423729, 720ft, VIEW W.

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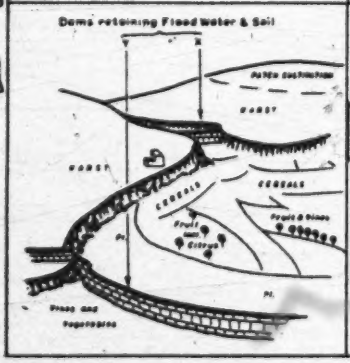
C: Detail of part of area shown in B



D: Santi Gap : Distribution of tree-crops

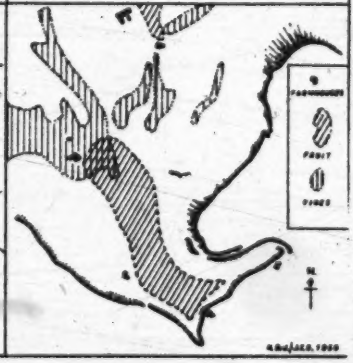


Fig. 107 Malta: Santi-Bingemma Uplands.

1: Bowen-Jones et al. K-5 (1955-1958) 1961
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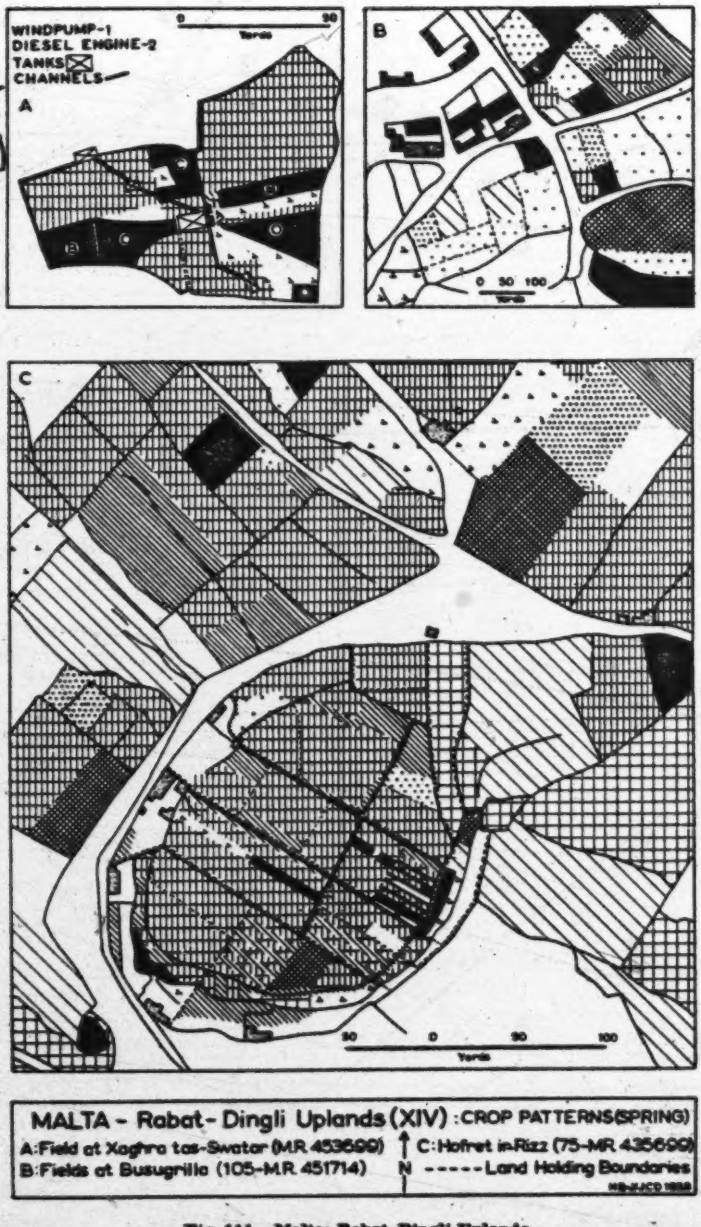

MALTA - Rabat - Dingli Uplands (XIV) : CROP PATTERNS (SPRING)
A: Field at Xaghra tas-Swatar (M.R. 453690) C: Hofret in-Rizz (75-M.R. 435690)
B: Fields at Busugrilla (105-M.R. 451714) N ----- Land Holding Boundaries

Fig. 111 Malta: Rabat-Dingli Uplands.

1: Bowen-Jones et al. K-5 (1955-1958) 1961
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E. The Farmers of Malta

From survey work, farm interviews and detailed case-studies we have been able to distinguish certain characteristic types of Maltese farmer. The variety of practice and productivity within the pseudo-peasantry makes it impossible to take general treatment any further, therefore in this section are presented a cross-section of such types. For obvious reasons, we cannot present details which might lead to the identification of any farmer or his landholding.

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1. THE PART-TIME FARMER

Numerically as important as full-time farmers this group, although heterogeneous, indicates the incompleteness of the recent 'flight from the land'. At the highest level, as in case-study (A), the stability given by a non-agricultural income encourages good land use.

A - A holding of c. 10 *tmien* in two blocks of 19 irrigable field plots in Region AII, Mellieha Isthmus, produces c. 60 per cent. of the cultivator's net income. Irrigated market gardening produces potatoes, tomatoes, artichokes, cucurbits, carrots, cauliflowers, garlic, lemons and table-grapes for sale, and beans, maize, celery and turnips for home consumption. Rents of reclaimed land on Government property are negligible. The farmer maintains that he holds the land partly to support the present family of three and to enable his eight adult emigrant sons to have some 'hobby' land when they return as expected to Malta. Nevertheless, his husbandry standards and commercial acumen are good, his yields high. This type of part-time farmer is neither common nor rare.

B - At the other extreme is a policeman who, in 1950, purchased 14 *tmien* of dry land in Region XVIIIb, ta'Qali, in order to have land to work after retirement. Of this, 10 *tmien* is let out on annual leases, both tenants' and landlord's responsibilities being ignored, and 6 *tmien* is 'cultivated' by the owner, carrying weed infested and diseased crops of wheat, sulla and broad beans. This is symptomatic of unhealthy economic and social conditions, viz. simple land hunger based on insecurity of urban occupations and inadequate pensions.

2. THE FULL-TIME ARABLE FARMER ON IRRIGATED LAND

The time-consuming nature of market gardening and the high value of irrigated *saqwi* land tend either to restrict the total size of holdings or to focus the farmer's attention on such land.

C - In Region XIV, two full-time farmer brothers with three dependants cultivate 7 *tmien* in one irrigated plot (Fig. 111A). One of the brothers returned from temporary migration to Canada in 1913 bringing some capital and ideas. Their equipment consists of hoes, an American windpump and an English diesel pump. There is a well graded irrigation system of three cisterns, overhead and ground level stone channelling. The diesel pump is used for filling the cisterns, the windpump for maintaining the water level. Both farmers share equally the cost of equipment and pumping and have a family arrangement for division of labour and produce. Surplus produce is sold in the Rabat market.

D - A full-time farmer with family of 11, six of whom are adults, working on holding of c. 30 *tmien* in Region A XV a The Blue Clay Basin (Fig. 141). Lives on a main plot of 14 *tmien* on Blue Clay and marl. On the main part of the holding are cultivated irrigated fruit and vegetable crops. The other plots consist mainly of rock, rough grazing and carobs with some vines. Intensive aboriculture is practised with peaches replacing plums and old apple stock being replaced by vines and peaches.
Livestock - 1 horse, 9 sheep, 13 pigs and 3 goats.
Equipment - *mohriet* and hoes. The farmer borrows a 'rotavator' for summer cultivation and has 'access' to lorry and jeep for marketing produce. The dwelling has piped water supply. Irrigation water is obtained from

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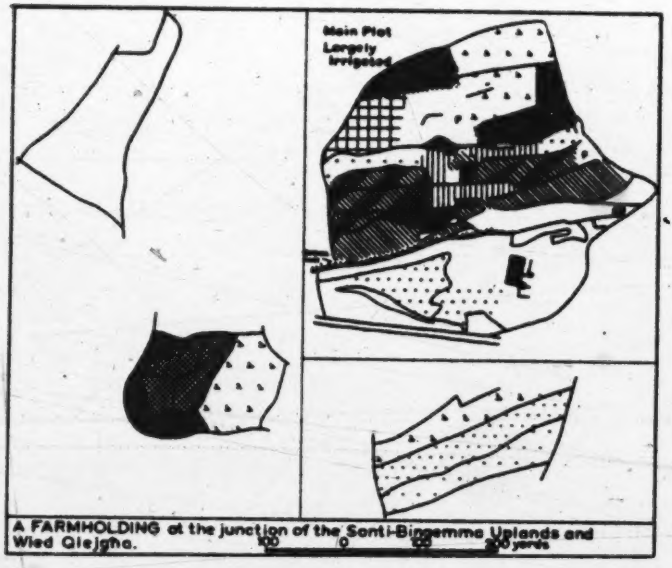

Fig. 141 A farmholding at the junction of the Santi-Bingemma Uplands and Wied Qiejgha.

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Upper Coralline aquifers overlying outcropping Blue Clay. The main supply, from a fissured Coralline cave now piped into a cistern, has only failed once (1950) since 1921. Water needs conserving in summer and is then only applied to special crops. Minor supplies come from 'wet weather' springs on Blue Clay slope.

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Soils - deep, weathered marls with thin clay beds, these latter being used for marling the Upper Coralline lands. In winter, the clay beds are too wet for most crops, e.g. during the 1953-54 season an attempt to grow wheat failed completely and, on 2nd April, 1955, drainage holes were necessary to hasten the percolation of surplus water in some fields. In summer, the clays need careful tilling in order to avoid caking. Produce is mainly for sale in Rabat market.

241 3. THE FULL-TIME DRYLAND ARABLE FARMER

This group is numerically and areally the most important. It also tends to set the general standard of farming.

E - The first example of this group works land in Region CXX, the Tarxien-Ghaxaq Basin. A full-time farmer with two dependants with a fairly concentrated holding of 32 *tmien* (8.7 acres), used as follows in spring:-

3.6 *tmien* of Sulla
5 *tmien* of Potatoes
5 *tmien* of Wheat
5 *tmien* of Barley
.5 *tmien* of Broad Beans (vegetable)

19.1

The remainder is under onions, aniseed, cumin, fallow and forages. The best land has 30 inches of soil and is rented at 26s. per *tomna*. The poorer

1: Bowen-Jones et al. K-5 (1955-1958) 1961
EZ6 Malta EZ6

for the evening meal, Rosary, and sleep. Electricity has made his time-table only slightly less dependent on the times of the rising and setting sun.

Increased spending-power, a more varied diet now including a variety of preserved and non-local foods, and the replacement of home-produced cotton by purchased materials for making clothes, have all contributed to the extension of shopping facilities in the villages. Apart from the 'general store', specialised shops have also made their appearance - butchers, pharmacists, clothing shops, and so on. The 1939-45 war brought flour and bread rationing and the end of home-baking - hence a further village specialisation (see p. 182). Since the War, the number of vans touring the countryside every week has increased rapidly to bring a variety of wares to the door of even the most lonely farmhouse. The *petrolju* van was early in the field, for the rural Maltese have long relied on paraffin for both cooking and such heating as the houses receive. Yet another addition in recent years to the diet of the poorer classes has been the free distributions of food (cheese, rice, corn-meal and flour) made by C.A.R.E. and by Catholic Relief Services (cheese, beans, flour, etc.), another organisation distributing surplus United States food supplies abroad.

Village housing is changing more slowly. The traditional Maltese rural home was a flat-roofed dwelling built round an enclosed courtyard, from which a staircase frequently led to an upper floor. The courtyard was the centre of domestic life and much of the regular work of the household was done here. A door, large enough to take a cart, opened on to the street. Windows on outside walls were small and rare. In many of the older parts of the villages, accommodation for animals and stores adjoins the rooms occupied by the family, the whole forming a compact economic and domestic unit. Water was carried from a village pump and sanitation, if any, was limited to independent cess-pits requiring periodic emptying. In winter such premises were liable to be very cold; in the heat of summer the rough roads of beaten earth readily produced a fine dust which can only have had harmful effects on the widespread trachoma and similar ailments.

Nowadays much of this survives only in the memory of the older people. Only some village streets in Gozo are not now surfaced; mains sewerage has been extended to all the larger villages of Malta; electricity is absent only in north-western Gozo; familiar red telephone kiosks have appeared all over the Islands; the larger villages in Malta have cinemas, in addition to much older Band Club buildings.

The essential features of the village society within which the Maltese farmer lives today may be summarised thus in conclusion:-

Economically, there has been a change from the independent, subsistent family unit to a diversified and inter-dependent occupational structure in the village, along with a realisation of the impossibility of maintaining Maltese agriculture in its traditional form without 'artificial' support. Materially, the village is seen to have benefited from a wide range of developments which have improved it as a place in which to live for the Maltese countryman with his now greater range of demands - and the buying-power with which to achieve them, thanks to war-time siege and subsequently to Government subsidy and guarantee. Socially, literacy and the awareness of a different way of life beyond the village have brought to the younger generation an intense dissatisfaction. Dissatisfaction not only with the social regime of the village, even in its present broadened and functionally diversified form, but also with the farming on which the community has depended.

Thus farming in its present form is waning and the Maltese farmer as he was in the recent past - and still is among the older generation - is a disappearing individual. If the clash between the present younger generation and the old order can be resolved and if the retreat from the land can be stemmed at all, a different kind of agriculture will emerge with a new type of farmer and a changed rural society.

REFERENCES

1. Census of the Maltese Islands 1948. Table 53.
2. C.A.R.E. - Co-operative for American Remittances to Everywhere.

Note: For a fuller consideration see E. W. Beeley: 'The Individual and Changing Rural Society in Malta', Ph.D. Thesis, Durham, 1960.

3: Buxton D-5 (1920-1921) 1922 EZ6 Malta EZ6

In Oxford, Professor Arthur Thomson has set the resources of his Department, including a calculating machine, at my disposal, and has helped me continually with advice and kindly criticism. My former teachers—Sir Arthur Evans, Mr. Henry Balfour, Mr. E. T. Leeds, and Professor J. L. Myres—have accorded me in many conversations the combined privileges of a colleague and a pupil. I fear that I have, albeit unwittingly, often pirated their ideas. My colleague, Miss Blackwood, has devoted the greater part of a Long Vacation to helping to finish and prepare this paper for the press before my leaving England, and has performed the laborious task of looking over proofs in my absence.

II.—Geography.

The Maltese archipelago consists of the islands of Malta, Gozo, Comino, Cominetto and Filfola. The two latter are uninhabited, and Comino is practically untenanted. We are therefore only concerned with the islands of Malta and Gozo.

Malta lies about 60 miles south of Sicily and 180 miles north of the African coast. Its maximum length is 18½ miles, its maximum breadth 8½ miles, and its area 95 square miles. Gozo is considerably smaller, and has an area of about 20 square miles.

Geologically, the islands are Late Eocene (3). The eastern and most thickly inhabited part of Malta consists of globigerina limestone, which overlies lower coralline limestone; in the western part these beds are covered with beds of greensand and blue clay or marl, over which lies the upper coralline limestone. The rock is everywhere extremely friable, and is perpetually disintegrating under the influence of wind and rain. Except in one or two places the soil is seldom more than a few inches deep.

The surrounding seas are warm and shallow; a rise of 50 fathoms would connect Malta and Sicily, and a rise of 200 fathoms would join North Africa and Europe and include Malta as a craggy bastion. The shallowest sea, however, lies more to the west. Malta should, therefore, be more correctly described as an outlying pier of an old land bridge rather than part of the land bridge itself. It seems probable that slow, tectonic movements are actually in progress to-day, and that the archipelago is sinking; but it is extremely unlikely that any men of whom we possess traces at present, with the doubtful exception of a few fragments from the Weid Dalam, came to Malta when it was still part of the mainland.

The island is tilted from south to north. The cliffs along the southern coast are high and precipitous, and some of the loftiest parts of the island are close to the shore.

The undercliff here forms a pleasant contrast to the less fertile parts of Malta. Carib trees are not uncommon, potatoes are cultivated on terraces, and the tiny fields are irrigated, as elsewhere in Malta, by little runlets conducted along channels

3: Buxton D-5 (1920-1921) 1922 EZ6 Malta EZ6

made of open stone pipes. On the rocks, in January, there was a wild profusion of flowering heath, of a species akin to our heather (*Erica*). Where the water overflows, there are tiny reed beds, but always smaller and less luxuriant than those of the Eastern Mediterranean. In some places on these cliffs the charlock appears to have competed successfully with *Oxalis cernua*.

The north coast is generally more shelving. There are no mountains, but the whole surface is cut by deep ravines, which are for the most part dry, but which may contain as much as three feet of water during a spate; the mouths of some of these valleys form small fiords. The western part of the island, which contains the upper coralline beds, contrasts strongly with the eastern. The hills are higher, the valleys bigger and more rounded, and the country is less parched, owing to the underlying marls. The scenery of Gozo resembles that of Western Malta, but the cliffs are higher and grander, the fields are larger, and the country is greener.

Owing to the large population every foot of soil is precious, and the whole of Malta is parcelled out into innumerable tiny fields, some hardly more than a few yards square, each being separated from the next by a stone wall. Olives and caribs grow as elsewhere in the Mediterranean, but for the most part they are limited to the courses of the streams; oranges flourish where there is sufficient water to irrigate them, but in Malta one looks in vain for the abundant orange groves of Sicily, or the pleasant tangled hillsides of Northern Cyprus. The myrtle is almost absent, the numbers of wild myrtle bushes can nearly be counted on the fingers of a man's hands. The flora (4) generally is most akin to that of Sicily; 94 per cent. of the Maltese species are found in that island, 91 per cent. in Africa, and 90·5 per cent. in the Levant (5). There are three things which are predominant in all the scenery of Malta: stone walls, goats, and the yellow flowers of the virulent *Oxalis cernua*, which not even the goats will eat.

Owing to the small size of Malta and the nature of its surface, the weather is dominated by two factors—the sea and the direction of the wind. The mean annual temperature is 66·6° F., the mean annual rainfall is 21·6 inches, precipitation normally occurring on 81 days. The mean relative humidity for seven years is 79·1 per cent. The coldest month is February (mean temperature 52·9° F.); the hottest August (77·9° F.). During June and July practically no rain falls, and in August the mean is only 0·13 mm. (6).

In working out constants, I have divided the islands into two areas—Urban and Rural. This is the division in the census (31), and corresponds very closely to a marked difference in the conditions under which the population lives. The former includes the fortified towns and suburbs, Valletta, Floriana, Cottoneria, Senglea, Conspicua, Sliema, St. Julian, Pieta Misida, Hamrum, Birchircara, Curmi, Paula, Tarxien, Zabbar, Calcara and Rabato; the latter, the more isolated villages in the country.

MAP 8
FARMSTEAD
CASE VI

[following p. 102]

1 MAIN ENTRANCE ROOM
2 LIVING-ROOM/BEDROOM
3 WELL
4 WATER (TAP)
5 POULTRY
6 RABBITS
7 STEPS TO CELLAR USED FOR SHEEP
8 CARTS
9 GENERAL YARD

OTHER BUILDINGS

0 1 2 3 4 5 6 7 8 9 10
YARDS

*159 231 The cattle are very mixed in breed including "Bastard-Inglizi", supposedly pure Friesians and crosses between the two.

*159 D. Capital.

(i) No freehold property.

421 (ii) In perpetual debt, no reserves and frequent borrowings, particularly from the Government.

[423]

[454] (iii) Equipment - usual hand tools

- rotary cultivator bought with a Government loan of £550, repayable at £100 p.a. plus 1% interest.

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- small motor van, bought in 1953, for transport of milk.

[312]

- no piped water until Feb. 1958.

E. Labour.

*159 464

- No permanent hired labour.
- One man and his daughter together at 30/- per diem and one youth at 25/- engaged at busy times.
- Family labour: two partners and their two eldest sons work full-time and there is additional help from wives and children.

F. Production and Sales.

*159 434 435

- Income almost entirely from sale of milk to M.M.U. Production varies greatly: June 1957: 50 galls. daily; Dec. 1957: 35; Feb. 1958: 80. Sold at 5/6 to 6/- per gall.
- Male calves sold to butcher at £10; females sometimes sold at £30-£40 to pay debts.
- No accounts kept of feeding costs. These include one truckload of prickly pear (30/-) daily from June to October, beans at 55/- per qantar and cake at 46/- (July 1957). A considerable amount of grazing is carried out e.g. on sulla bought green at £6 per tomna.
- Potato sales insignificant and in 1957, owing to glut, involved a loss.

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- Vegetables produced are all consumed by the families.

G. Husbandry.

*159 231 (i) - The importance attached to grazing of cattle is unusual. (Most Maltese cattle are stall-fed all the year.)

- The emphasis is on numbers of stock rather than on their quality. The turn-over from goats to cattle has been helped by the government exchange scheme and by Govt. loans.

[232]

- Occasional outbreaks of disease unnoticed until too late.

[241] (ii) - Crops are often neglected owing to time involved in animal husbandry.

*159 234 829 H. General.

The partnership is attempting to profit from guaranteed milk prices without the knowledge or skill to do so. The herd seems to have been built up beyond the numbers which can be properly tended by the labour available.

There is little knowledge of modern methods and still less of costs and returns. The view is firmly held that "cows yield according to the amount they are fed" and the reply to the question "How much fodder is required to produce a gallon of milk was "Min jaf?" (Who knows?).

The partners are extremely conservative in their attitude to marketing, suspicious of outside interference and hostile towards the idea of co-operatives. Yet they expect

[426] continued Government assistance.

Their general pessimistic attitude is summed up: "Il-bieđja f'Malta spiċċat" (Farming in Malta is finished).

Despite guaranteed milk prices on which the whole economy is based, the partnership is permanently in debt.